

REMARKS

The title is amended as required.

Claims 1-8 were rejected under §102 over the Musaka article. This rejection is respectfully traversed. Claim 1, as exemplified in the drawing, recites

embedding a copper wiring layer [4] into a plug comprised of a semiconductor substrate [1];

forming a compound of copper [5] into the copper wiring layer from thereabove;

forming a reactive layer [6] and a barrier metal layer [7] interdiffused with the copper wiring layer on the compound of copper; and

interdiffusing the copper compound and the reactive layer by heat treatment to thereby form an alloy layer of copper [8] between the copper wiring layer and the barrier metal layer.

The claim is believed not to be anticipated as follows:

(1) Musaka's barriers best correspond to the Applicant's barrier 3, shown in Fig. 1, which is not a feature recited in claim 1. The barrier metal layer recited in claim 1 is exemplified by layer 7 in Fig. 1, which is formed *over* the Cu, which is opposite to what Musaka discloses. Musaka discloses barrier materials formed under Cu, not over it.

In the second paragraph of the Introduction section in col. 1 on page 83, Musaka writes, “One of the problems of [Cu is] dewetting of Cu from the *underlying* barrier material” (emphasis added). In the Experimental section in col. 2 of the same page, Musaka discloses four barrier materials (Ta(N) bi-layer, Ta, TiN, and TiSiN), and describes preparation of samples “with blanket ECP Cu (1.3 μm)/PVD Cu (200nm)/barrier film over ... SiO₂ substrates.... [also] second set of samples with blanket PVD Cu(10-20nm)/ barrier film on ... SiO₂ substrates... [and a] third

set of samples with blanket ECP Cu (1.3 μm)/PVD Cu (200nm)/barrier films on SiO₂ substrates". This is seen to describe a barrier layer *between* the Cu and the substrate.

Thus, Musaka's disclosure amounts to adding an additional step into the claimed "embedding a copper wiring layer into a plug provided on a semiconductor substrate," namely, forming a barrier layer between the semiconductor substrate and the copper plug.

(2) Musaka does not disclose the claimed compound of copper; it does not disclose that such a compound is covered by a reactive layer; and it does not disclose that such a reactive layer is covered with a barrier metal layer.

The rejection asserts that each feature recited in the claims is anticipated by Musaka, but, with respect, the rejection does not state where in the reference the asserted anticipations occur, and no such anticipation is seen. For example, no mention of a copper alloy or compound is seen anywhere in the reference. The Office Action includes not a single citation in support of the rejection.

(3) There is no disclosure of the claimed interdiffusing, and Musaka does not disclose heating layers to form a copper alloy. Musaka heats its finished devices in order to test them, not in order to form them (page 83, col. 1, line 7 of Abstract and second paragraph of Introduction; page 84, paragraphs describing Figs. 3-5). No citation is given to support the Examiner's assertion that these features of claim 1 are anticipated.

(4) Similarly, independent claim 5 is not anticipated. There is no disclosure of a substance interdiffused with the copper wiring layer, as claimed, and the other features of claim 5, which are also found in claim 1, are likewise not anticipated by the arguments above.

(5) The dependent claims also are not anticipated. In relation to claims 2 and 6, Musaka does not teach nitriding, boronizing, etc. Musaka only shows that TiSiN is formed by SiH₄ soaking of TiN.

As to claims 3 and 7, Musaka does not disclose a reactive layer containing any of the listed substances, because it does not disclose a reactive layer. Musaka teaches no reaction.

The dependent claims are all also patentable by their dependence.

For the reasons above, withdrawal of the rejection and allowance of the claims is requested.

Respectfully submitted,

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Date


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